(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 354 016 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
21.02.1996 Bulletin 1996/08

(51) Int Cl.[6]: **C11D 3/00**, C11D 3/37

(21) Application number: **89307851.9**

(22) Date of filing: **02.08.1989**

(54) **Dispersible silicone antifoam formulations**

Dispergierbare Silikon-Antischaum-Formulierungen

Formulations au silicone anti-moussantes et dispersables

(84) Designated Contracting States:
BE DE ES FR GB NL

(30) Priority: **04.08.1988 US 228079**

(43) Date of publication of application:
07.02.1990 Bulletin 1990/06

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FR-A- 2 328 040
GB-A- 2 119 394

Remarks:

The file contains technical information submitted after the application was filed and not included in this specification

Printed by Jouve, 75001 PARIS (FR)

EP 0 354 016 B1

Description

This invention relates to a dispersible silicone antifoam composition for providing controlled foaming liquid laundry detergent formulations and wherein there is provided a non-aqueous emulsion of primary and secondary antifoam agents, the primary antifoam agent being a reaction product of (a) a polyorganosiloxane fluid having at least one hydroxyl and a hydrocarbonoxy group, (b) a resinous siloxane or a silicone resin-producing silicon compound, (c) a finely divided filler material, and (d) a catalyst to promote the reaction of (a) to (c), the secondary antifoam agent being a polydimethysiloxane fluid, at least one nonionic silicone surfactant for emulsifying the primary and secondary antifoam agents in a solvent, a first organic surfactant dispersing agent for assisting in dispersing the emulsified primary and secondary antifoam agents in the liquid laundry detergent and a second dispersing agent of a nonionic difunctional block-copolymer terminating in primary hydroxyl groups for further assisting in dispersing the emulsified primary and secondary antifoam agents in the liquid laundry detergent.

The invention also relates to a dispersible silicone antifoam composition for providing controlled foaming aqueous medium formulations and wherein there is provided a non-aqueous emulsion of primary and secondary antifoam agents, the primary antifoam agent being a reaction product of (a) a polyorganosiloxane fluid having at least one hydroxyl and a hydrocarbonoxy group, (b) a resinous siloxane or a silicone resin-producing silicon compound, (c) a finely divided filler material, and (d) a catalyst to promote the reaction of (a) to (c), the secondary antifoam agent being a polydimethysiloxane fluid, at least one nonionic silicone surfactant for emulsifying the primary and secondary antifoam agents in a solvent, a first organic surfactant dispersing agent for assisting in dispersing the emulsified primary and secondary antifoam agents in the aqueous medium and a second dispersing agent of a nonionic difunctional block-copolymer terminating in primary hydroxyl groups for further assisting in dispersing the emulsified primary and secondary antifoam agents in the aqueous medium.

In another embodiment of the present invention, the primary antifoam agent may also include a polyorganosiloxane fluid which is substantially free of reactive groups. The nonionic silicone surfactant is a material including trimethylsilyl endcapped polysilicate which has been condensed with a polyalkylene glycol or diester in a solvent. Optionally, another silicone surfactant can be included such as a copolymer of polymethylsiloxane and polyalkylene oxide in a solvent. In a specific embodiment, the secondary antifoam agent has a viscosity of about one thousand centistokes, the solvent is polypropylene glycol having an average molecular weight of about two thousand and the block copolymer is an ethylene oxide-propylene oxide block copolymer.

The most preferred primary antifoam agent is that formulation of US-A- 4,639,489 and 4,749,740, which formulation covers a silicone defoamer composition produced by reacting at a temperature of 50°C. to 300°C :

(1) 1 to 100 parts by weight of a polyorganosiloxane having a viscosity of 2×10^{-5} to $1 \times 10^{-1} m^2/s$ (20 to 100,000 cs) at 25°C. and being expressed by the general formula $R^1{}_aSiO_{(4-a)/2}$ in which R^1 is a monovalent hydrocarbon or halogenated hydrocarbon group having 1 to 10 carbon atoms and a has an average value of from 1.9 to 2.2;

(2) less than five parts by weight of a polyorganosiloxane having a viscosity of 2×10^{-4} to several m^2/s (200 to several million cs)at 25°C. expressed by the general formula $R^2{}_b(R^3O)_cSiO_{(4-b-c)/2}$ in which R^2 is a monovalent hydrocarbon or halogenated hydrocarbon group having 1 to 10 carbon atoms, R^3 is hydrogen or a monovalent hydrocarbon group having 1 to 10 carbon atoms, b has an average value of from 1.9 to 2.2 and c has a sufficiently large value to give at least one $-OR^3$ group in each molecule, said $-OR^3$ group being present at least at the end of at molecular chain; the total of components (1) and (2) being 100 parts by weight;

(3) 0.5 to 20 parts by weight for every 100 parts by weight of said components (1) and (2) of one or more compounds selected from the following a) to d):

a) an organosilicon compound of the general formula $R^4{}_dSiX_{4-d}$ in which R^4 is a monovalent hydrocarbon group having 1 to 5 carbon atoms, X is a hydrolyzable group and d has an average value of one or less;

b) a partially hydrolyzed condensate of said compound a);

c) a siloxane resin consisting essentially of $(CH_3)_3SiO_{1/2}$ and SiO_2 units and having a $(CH_3)_3SiO_{1/2}/SiO_2$ ratio of 0.4/1 to 1.2/1; and

d) a condensate of said compound c) with said compound a) or b);

(4) 0.5 to 30 parts by weight of a finely divided filler for every 100 parts by weight of said components (1) and (2);

(5) a catalytic amount of a compound for promoting the reaction of the other components; and

(6) 0 to 20 parts by weight, for every 100 parts by weight of said components (1) and (2), of a polyorganosiloxane having a viscosity of 5×10^{-6} to $2 \times 10^{-4} m^2/s$ (5 to 200 cs) at 25°C. and being expressed by the general formula $R^8{}_e(R^9O)_fSiO_{(4-e-f)/2}$ in which R^8 is a monovalent hydrocarbon or halogenated hydrocarbon group having 1 to 10 carbon atoms, R^9 is hydrogen or a monovalent hydrocarbon group having 1 to 10 carbon atoms, e is from 1.9 to 2.2 on an average and f has a sufficiently large value to give at least two $-OR^9$ groups in each molecule at the end of a molecular chain.

In this formulation, the R^1 groups of component (1), the R^2 groups of component (2) and the R^8 groups of component (6) are hydrocarbon groups; the X groups of component (3) a) are $-OR^6$ groups or $-OR^6OR^7$ groups in which R^6 is a divalent hydrocarbon group having 1 to 5 carbon atoms and R^5 and R^7 are each hydrogen or a monovalent hydrocarbon group having 1 to 5 carbon atoms; component (4) is silica; and component (5) is a compound selected from the group consisting of alkali metal hydroxides, alkali metal silanolates, alkali metal alkoxides and metal salts of organic acids. Further, component (1) is a trimethylsiloxy-endblocked polydimethylsiloxane fluid having a viscosity of from 3.5×10^{-4} to 1.5×10^{-2} m^2/s (350 to 15,000 centistokes) at 25°C.; component (2) is a hydroxyl-endblocked polydimehtylsiloxane fluid having a viscosity of from 1×10^{-3} to 5×10^{-2} m^2/s (1,000 to 50,000 centistokes) of 25°C.; component (4) is a silica having a surface area of from 50 to 500 m^2/g; and component (6) is a hydroxylendblocked polydimethylsiloxane having a viscosity of from 1×10^{-5} to 5×10^{-5} m^2/s (10 to 50 centistokes) at 25°C.

It is, therefore, an object of the present invention to provide an easily dispersible silicone antifoam composition for use in a liquid laundry detergent and wherein there is provided controlled foaming behavior.

It is another object of the present invention to provide a homogeneously dispersible silicone antifoam formulation for a liquid laundry detergent or an aqueous medium and wherein the antifoam composition can be dispersed into the liquid laundry detergent or the aqueous medium in order to form stable, relatively clear formulations having controlled foaming behavior.

These and other features, objects and advantages, of the herein described present invention will become apparent when taken in conjunction with the following detailed description.

The single figure of drawing is a functional representation of automated pump testing apparatus used to determine the performance of antifoam compositions under conditions designed to simulate consumer use.

In accordance with the present invention, an antifoam formulation is provided wherein an antifoam is rendered dispersible in aqueous mediums, especially liquid laundry detergents, by means of a plurality of particular surfactant and dispersing agents which function as emulsifying ingredients. Preferred emulsifying and dispersing ingredients for the purposes of the present invention are the nonionic or anionic surfactant type. In nonionic surfactants, for example, there is no charge on the molecule and the solubilizing groups are ethylene oxide chains and hydroxyl groups. Such nonionic surfactants are compatible with ionic and amphoteric surfactants and representative of nonionic surfactants are, for example, polyoxyethylene or ethoxylate surfactants such as alcohol ethoxylates and alkylphenol ethoxylates. Carboxylic acid ester nonionic surfactants include glycerol esters, polyoxyethylene esters, anhydrosorbitol esters, ethoxylated anhydrosorbitol esters, natural fats, oils and waxes and ethoxylated and glycol esters of fatty acids. Carboxylic amide nonionic surfactants which may be included are diethanolamine condensates, monoalkanolamine condensates and polyoxyethylene fatty acid amide. Representative of polyalkylene oxide block copolymer nonionic surfactants are the polyalkylene oxides derived from ethylene, propylene, butylene, styrene and cyclohexene. Typical of the anionic surfactants that may be employed herein are salts of alkyl sulfates, salts of alkylaryl sulfates, salts of alkyl ether sulfates, salts of alkylaryl ether sulfates and salts of alkylaryl sulfonates. Exemplary materials included are, for example, alkyl benzene sulfonates, alkyl glyceryl ether sulfonates, alkyl phenol ethylene oxide ether sulfates, esters of alpha-sulfonated fatty acids, 2-acyloxyalkane-1-sulfonic acids, olefin sulfonates, beta-alkyloxyalkane sulfonates, anionic surfactants based on higher fatty acids and tallow range alkyl sulfates. Both categories of surfactant are well known in the art and are described in more or less detail in US-A- 4,075,118, issued February 21, 1978, for example.

Because, as noted hereinbefore, antifoams are difficultly dispersible in aqueous mediums such as liquid laundry detergent formulations, the particular combination of surfactants and dispersants used herein is important in accordance with the present invention in that such surfactant-dispersant combinations serve to render antifoams easily dispersible, emulsifiable and homogeneous in aqueous medium applications. According to the present invention, the preferred silicone antifoam formulation which forms the basis of the primary antifoam agent used herein, is the defoamer composition disclosed and described in US-A- 4,639,489, issued January 27, 1987 and US-A- 4,749,740 issued June 7, 1988 and which defoamer composition is a multi-component system. The defoamer composition of US-A- 4,639,489 and 4,749,740, includes as multi-components a mixture of (a) a polyorganosiloxane fluid having at least one hydroxyl and/or hydrocarbonoxy group, (b) a polyorganosiloxane fluid which is substantially free of reactive groups, (c) a resinous siloxane or a silicone resin-producing silicon compound, (d) a finely divided filler material, and (e) a catalyst to promote the reaction of (a) to (d). The specifics and details of each of the various components of this primary antifoam composition are set forth in the aforementioned US-A- 4,639,489 and No. 4,749,740.

The antifoam composition of the present invention also includes a secondary antifoam agent for use in conjunction with the primary antifoam agent and the secondary antifoam agent is described hereinafter.

In order to render the primary and secondary antifoam agents dispersible in aqueous medium, more particularly liquid laundry detergent formulations, there is included along with the two antifoam agents, at least one nonionic silicone surfactant for emulsifying the primary and secondary antifoam agents in a solvent; an organic surfactant dispersing agent for assisting in dispersing the emulsified primary and secondary antifoam agents in the

liquid laundry detergent and a dispersing agent of a nonionic difunctional block-copolymer terminating in primary hydroxyl groups for further assisting in dispersing the emulsified primary and secondary antifoam agents in the liquid laundry detergent. One nonionic silicone surfactant can be a copolymer of polymethylsiloxane and polyalkylene oxide in a solvent or a material including trimethylsilyl endcapped polysilicate which has been condensed with a polyalkylene glycol or diester in a solvent. The term solvent as used herein is intended to include polypropylene glycol having an average molecular weight of about two thousand. The block copolymer preferred is an ethylene oxide-propylene oxide block copolymer. The nonionic organic surfactant employed is TRITON® X-100, a material of the formula $C_8H_{17}C_6H_4(OCH_2CH_2)_9OH$, manufactured by Rohm and Haas, Philadelphia, Pennsylvania. TRITON® is a registered trademark of Rohm and Haas. The block-copolymer employed is PLURONIC® L-101, a product of BASF-Wyandotte Corporation, Parsippany, New Jersey. PLURONIC® is a registered trademark of BASF-Wyandotte. PLURONIC® L-101 is a difunctional block-copolymer terminating in primary hydroxyl groups and with a molecular weight that may range from about one to about fifteen thousand. PLURONIC® L-101 is a polyalkylene oxide derivative of propylene glycol.

While the compositions of the present invention can be used in conjunction with many formulations of detergents, by way of example, the liquid laundry detergent compositions set forth in US-A- 4,318,818, issued March 9, 1982; 4,507,219, issued March 26, 1985; 4,515,705, issued May 7, 1985; and 4,597,898, issued July 1, 1986; are most exemplary. The antifoam formulations of the present invention can be mixed directly into such liquid laundry detergents to provide an essentially clear detergent with reduced foaming behavior. Preferably, the primary and the secondary antifoam agents are mixed and emulsified in polypropylene glycol of average molecular weight of about two thousand, with the two nonionic silicone surfactants, followed by addition of the organic nonionic surfactant and the block-copolymer, and then the formulation is mixed with the aqueous medium, or in the preferred embodiment, a liquid laundry detergent of the type noted above. The various components of the formulation of the present invention, other than the particular antifoam components of US-A- 4,639,489 and 4,749,740, function as the delivery mechanism for the antifoam composition of US-A- 4,639,489 and 4,749,740, in order to permit dispersion of the antifoam of US-A- 4,639,489 and 4,749,740, in aqueous mediums.

The polydimethylsiloxane used herein as the secondary antifoam agent is a polymer having a molecular weight in the range from 200 to about 200,000 and have a viscosity in the range from 2×10^{-5} to 2×10^{0} m^2/s (20 to 2,000,000) centistokes, preferably from 5×10^{-4} to 5×10^{-2} m^2/s (500 to 50,000 centistokes), more preferably 1×10^{-3} m^2/s (1,000 centistokes) at 25°C. The siloxane polymer is generally end-blocked either with trimethylsilyl or hydroxyl groups but other end-blocking groups are also suitable. The polymer can be prepared by various techniques such as the hydrolysis and subsequent condensation of dimethyldihalosilanes or by the cracking and subsequent condensation of dimethylcyclosiloxanes.

The polydimethylsiloxane secondary antifoam agent can be present in combination with particulate silica. Such combinations of silicone and silica can be prepared by affixing the silicone to the surface of silica for example by means of the catalytic reaction disclosed in US-A- 3,235,509. Foam regulating agents comprising mixtures of silicone and silica prepared in this manner preferably comprise silicone and silica in a silicone: silica ratio of from 20:1 to 200:1, preferably 25:1 to 100:1. The silica can be chemically and/or physically bound to the silicone in an amount which is preferably 0.5% to 5% by weight, based on the silicone. The particle size of the silica employed in such silica/silicone foam regulating agents is finely divided and should preferably be not more than 100 millimicrons preferably from 10 millimicrons to 20 millimicrons and the specific surface area of the silica should exceed about 50 m^2/g.

Alternatively, silicone and silica can be prepared for use as the secondary antifoam agent by admixing a silicone fluid of the type herein disclosed with a hydrophobic silica having a particle size and surface area in the range disclosed above. Any of several known methods may be used for making a hydrophobic silica which can be employed herein in combination with a silicone as the secondary foam regulating agent. For example, a fumed silica can be reacted with a trialkyl chlorosilane (i.e., "silanated") to affix hydrophobic trialkylsilane groups on the surface of the silica. In a preferred and well known process, fumed silica is contacted with trimethylchlorosilane. A preferred material comprises a hydrophobic silanated (most preferably trimethylsilanated) silica having a particle size in the range from 10 millimicrons to 20 millimicrons and a specific surface area above about 50 m^2/g intimately admixed with a dimethylsilicone fluid having a molecular weight in the range of from 500 to 200,000, at a weight ratio of silicone to silanated silica of from 20:1 to 200:1, preferably from 20:1 to 100:1.

Yet another type of material suitable herein as the secondary antifoam comprises polydimethylsiloxane fluid, a silicone resin and silica. The silicone "resins" used in such compositions can be any alkylated silicone resins, but are usually those prepared from methylsilanes. Silicone resins are commonly described as "three-dimensional" polymers arising from the hydrolysis of alkyl trichlorosilanes, whereas the silicone fluids are "two-dimensional" polymers prepared from the hydrolysis of dichlorosilanes. The silica components of such compositions are microporous materials such as fumed silica aerogels and xerogels having particle sizes and surface areas herein-above disclosed.

The mixed polydimethylsiloxane fluid/silicone res-

in/silica materials useful in the present compositions as secondary antifoam agents can be prepared in the manner disclosed in US-A- 3,455,839. Preferred materials of this type comprise:

(a) from about 10 parts to about 100 parts by weight of a polydimethylsiloxane fluid having a viscosity in the range from 20 to 30,000 mm/s at 25°C.;
(b) 5 to 50 parts by weight of a siloxane resin composed of $(CH_3)_3SiO_{1/2}$ units and SiO_2 units in which the ratio of the $(CH_3)_3$ $SiO_{1/2}$ units to the SiO_2 units is within the range of from 0.6/1 to 1.2/1; and
(c) 0.5 to 5 parts by weight of a silica aerogel. Such mixtures can also be sorbed onto and into a water-soluble solid.

Antifoam compositions prepared in accordance with the present invention were prepared and tested in order to demonstrate their defoaming capabilities and to determine the effectiveness of the antifoam compositions.

Testing of the invention was carried out to determine the performance under conditions designed to simulate consumer use. The apparatus used was an automated pump tester. The pump tester apparatus is shown in the drawing and consists of a large 15 gallon cylindrical plastic vessel for holding a quantity of simulated wash liquor or laundry detergent in water and two pumps which circulate the wash liquor. Plastic hoses are arranged so that the wash liquor is drawn from the vessel by the first pump and passed through a valve where a controlled amount of air is introduced into the liquid. A second pump mixes the air and wash liquor and returns the mixture to the vessel. When the pumps are started, a column of foam collects on the surface of the liquid in the vessel. The height of this foam column is detected by an ultrasonic ranging device which is connected to a computer so that foam height measurements are recorded at regular time intervals. Thus the apparatus is used to generate a series of foam height versus time plots which are used to determine the performance of foam control agents.

The wash liquor is prepared by dispersing a measured amount of a commercial liquid laundry detergent in 8.6 liters of deionized water to which has been added a known amount of calcium chloride solution. The purpose of the calcium chloride is to simulate water hardness, which is known to have an effect on the foaming properties of laundry detergents. The amount of liquid laundry detergent added to the simulated hard water is calculated by taking the detergent manufacturer's recommended amount for a washing machine and reducing it buy a factor to account for the difference in volume between a typical washing machine and the 8.6 liter volume used in the pump tester. For every evaluation, the foaming behavior of a particular liquid laundry detergent was compared to the same detergent to which the foam control composition has been added. Results of these tests are indicated below.

Example I

DASH® liquid laundry detergent manufactured by The Procter & Gamble Company, Cincinnati, Ohio, was selected as the control. This type of detergent typically includes surfactants such as linear aryl sulfonates, alkyl ether sulfates and alkyl ethoxylates; a foam control agent of coconut fatty acid soap; builder-buffers such as sodium citrate, sodium tripolyphosphate and organic amines; hydrotropes such as propylene glycol, ethanol and sodium xylene sulfonate; and other ingredients such as enzymes, enzyme stabilizers, optical brighteners, perfumes, and dyes; and is described in more or less detail in the above mentioned US-A- 4,318,818, 4,507,219, 4,515,705 and 4,597,898. Seventeen and one-half grams of clear DASH® liquid laundry detergent was added to the pump tester apparatus shown in the drawing, containing 8.6 liters of deionized water to which had been added calcium chloride to provide a concentration of calcium ions equivalent to sixty parts per million. The temperature of the water in the tank was sixty degrees Fahrenheit. The simulated wash liquor was recirculated through the pumps, air bleed valve and tank, and the foam height monitored by the ultrasonic sensor and recorded every forty seconds. The recirculation was continued for six hundred seconds and the average recorded foam height of the DASH® liquid laundry detergent was found to be 23.3 centimeters at the end of ten minutes.

Example II

Example I was repeated except that to the liquid laundry detergent, there was added one-tenth of one percent by weight of the dispersible antifoam composition of the present invention. The composition was formulated by first preparing a master batch of two hundred grams of antifoam composition. The antifoam composition included in parts by weight, twenty parts of the primary antifoam agent, being that composition set forth in US-A- 4,639,489 and 4,749,740; ten parts of polydimethylsiloxane secondary antifoam agent of a viscosity of about one thousand centistokes; four and one-half parts of nonionic silicone surfactant of trimethysilyl endcapped polysilicate; one and one-half parts of TRITON® X-100 being a nonionic organic surfactant; ten parts of PLURONIC® L-101 being another nonionic organic surfactant; and fifty-four parts of polypropylene glycol of an average molecular weight of about two-thousand. The pump test of Example I was repeated including DASH® liquid laundry detergent to which had been added one-tenth of one percent by weight of the foregoing antifoam composition. The simulated wash liquor including the DASH® liquid laundry detergent and the antifoam composition of the present invention was recirculated through the pumps, air bleed valve and tank and the foam height monitored by the ultrasonic sensor and recorded every forty seconds. The recirculation was con-

tinued for six hundred seconds and the average recorded foam height of the DASH® liquid laundry detergent containing the antifoam composition of the present invention was found to be 13.5 centimeters at the end of ten minutes, a reduction in foam height of almost ten centimeters as compared to the DASH® liquid laundry detergent of Example I which did not contain the antifoam composition of the present invention.

Example III

Example II was repeated except that instead of TRITON® X-100, there was substituted one part of TRITON® X-405 a nonionic organic surfactant and an octylphenoxy polyethoxy ethanol composition and one-half of one part of TRITON® W-30 an anionic organic surfactant and the sodium salt of an alkylaryl polyether sulfate. The PLURONIC® L-101 was also used in an amount of five parts instead of ten parts and the amount of polypropylene glycol was increased from fifty-four parts to fifty-nine parts. The pump test of Example II was repeated including DASH® liquid laundry detergent to which had been added one-tenth of one percent by weight of the foregoing modified antifoam composition. The simulated wash liquor including the DASH® liquid laundry detergent and the modified antifoam composition of the present invention was recirculated through the pumps, air bleed valve and tank and the foam height monitored by the ultrasonic sensor and recorded every forty seconds. The recirculation was continued for six hundred seconds and the average recorded foam height of the DASH® liquid laundry detergent containing the modified antifoam composition of the present invention was found to be 14.6 centimeters at the end of ten minutes, a reduction in foam height of almost nine centimeters as compared to the DASH® liquid laundry detergent of Example I which did not contain the antifoam composition of the present invention. Both the compositions of Examples II and III when mixed with the clear yellow colored liquid laundry detergent were found to result in yellowish solutions of relative clarity.

Example IV

Example I was repeated except that in addition to the DASH® liquid laundry detergent, there was included in the wash liquor one-tenth of one percent by weight of detergent of antifoam composition comparable to that described in Example No. 1 of the Keil US-A- 3,784,479. The simulated wash liquor was recirculated through the pumps, air bleed valve and tank and the foam height monitored by the ultrasonic sensor and recorded every forty seconds. The recirculation was continued for six hundred seconds and the average recorded foam height of the DASH® liquid laundry detergent containing the Keil antifoam formulation was found to be about 20.9 centimeters at the end of ten minutes, indicating that the formulation in Keil is not as effective as an antifoam agent in liquid laundry detergents as are the formulations of the present invention and furthermore forms relatively hazy mixtures.

Whereas the particulate material of the secondary antifoam agent of the present invention has been illustrated by means of silica, it should be understood that other equivalent particulate materials may be used in accordance with the present invention. Thus, for example, there can be used in place of or in addition to silica, high surface area particulates such as crushed quartz, zirconium silicate, aluminum silicate, mica, ground glass and sand. The term "silica" as used herein is intended to include, for example, silica such as fume silica, precipitated silica and treated silica such as fume silica and precipitated silica that has been reacted with an organohalosilane, a disiloxane or disilizane.

It will be apparent from the foregoing that many other variations and modifications may be made in the structures, compounds, compositions and methods described herein without departing substantially from the essential features and concepts of the present invention. Accordingly, it should be clearly understood that the forms of the invention described herein are exemplary only and are not intended as limitations on the scope of the present invention.

Claims

1. A dispersible silicone antifoam composition for providing controlled foaming aqueous medium formulations, comprising an emulsion of a primary antifoam agent being a reaction product of (a) a polyorganosiloxane fluid having at least one hydroxyl and hydrocarbonoxy group, (b) a resinous siloxane or a silicone resin-producing silicon compound, (c) a finely divided filler material, and (d) a catalyst to promote the reaction of (a), (b) and (c), characterised in that the composition is a non-aqueous emulsion and further contains a secondary antifoam agent being a polydimethysiloxane fluid, at least one nonionic silicone surfactant, a first organic surfactant dispersing agent and a second dispersing agent of a nonionic difunctional block copolymer terminating in primary hydroxyl groups.

2. A dispersible silicone antifoam composition according to claim 1, in which the primary antifoam agent additionally comprises a polyorganosiloxane fluid which is free of reactive groups.

3. A dispersible silicone antifoam composition according to claim 1, in which the primary antifoam agent is formed by reacting at a temperature of 50°C, to 300°C.:

   (1) 1 to 100 parts by weight of a polyorganosiloxane having a viscosity of $2x10^{-5}$ to $1x10^{-1}$ m^2/s (20 to 100,000 cs) at 25°C. and being

expressed by the general formula $R^1_aSiO_{(4-a)/2}$ in which R^1 is a monovalent hydrocarbon or halogenated hydrocarbon group having 1 to 10 carbon atoms and a has an average value of from 1.9 to 2.2;

(2) less than five parts by weight of a polyorganosiloxane having a viscosity of $2x10^{-4}$ to several m^2/s (200 to several million cs) at 25°C. expressed by the general formula $R^2_b(R^3O)_cSiO_{(4-b-c)/2}$ in which R^2 is a monovalent hydrocarbon or halogenated hydrocarbon group having 1 to 10 carbon atoms, R^3 is hydrogen or a monovalent hydrocarbon group having 1 to 10 carbon atoms, b has an average value of from 1.9 to 2.2 and c has a sufficiently large value to give at least one $-OR^3$ group in each molecule, said $-OR^3$ group being present at least at the end of a molecular chain; the total of components (1) and (2) being 100 parts by weight;

(3) 0.5 to 20 parts by weight for every 100 parts by weight of said components (1) and (2) of one or more compounds selected from the following a) to d):

a) an organosilicon compound of the general formula $R^4_dSiX_{4-d}$ in which R^4 is a monovalent hydrocarbon group having 1 to 5 carbon atoms, X is a hydrolyzable group and d has an average value of one or less;
b) a partially hydrolyzed condensate of said compound a);
c) a siloxane resin consisting essentially of $(CH_3)_3SiO_{1/2}$ and SiO_2 units and having a $(CH_3)_3SiO_{1/2}/SiO_2$ ratio of 0.4/1 to 1.2/1; and
d) a condensate of said compound c) with said compound a) or b);

(4) 0.5 to 30 parts by weight of a finely divided filler for every 100 parts by weight of said components (1) and (2);

(5) a catalytic amount of a compound for promoting the reaction of the other components; and

(6) 1 to 20 parts by weight, for every 100 parts by weight of said components (1) and (2), of a polyorganosiloxane having a viscosity of $5x10^6$ to $2x10^{-4}$ m^2/s (5 to 200 cs) at 25°C. and being expressed by the general formula $R^8_e(R^9O)_fSiO_{(4-e-f)/2}$ in which R^8 is a monovalent hydrocarbon or halogenated hydrocarbon group having 1 to 10 carbon atoms, R^9 is hydrogen or a monovalent hydrocarbon group having 1 to 10 carbon atoms, e is from 1.9 to 2.2 on an average and f has a sufficiently large value to give at least two $-OR^9$ groups in each molecule at the end of a molecular chain.

4. A dispersible silicone antifoam composition according to claim 1, in which the primary antifoam agent is formed by reacting at a temperature of 50°C. to 300°C.:

(1) less than five parts by weight of a polyorganosiloxane having a viscosity of $2x10^{-4}$ to several million m^2/s (200 to several million cs) at 25°C. expressed by the general formula $R^2_b(R^3O)_cSiO_{(4-b-c)/2}$ in which R^2 is a monovalent hydrocarbon or halogenated hydrocarbon group having 1 to 10 carbon atoms, R^3 is hydrogen or a monovalent hydrocarbon group having 1 to 10 carbon atoms, b has an average value of from 1.9 to 2.2 and c has a sufficiently large value to give at least one $-OR^3$ group in each molecule, said $-OR^3$ group being present at least at the end of a molecular chain;
(2) 0.5 to 20 parts by weight for every 100 parts by weight of component (1) of one or more compounds selected from the following a) to d):

a) an organosilicon compound of the general formula $R^4_dSiX_{4-d}$ in which R^4 is a monovalent hydrocarbon group having 1 to 5 carbon atoms, X is a hydrolyzable group and d has an average value of one or less;
b) a partially hydrolyzed condensate of said compound a);
c) a siloxane resin consisting essentially of $(CH_3)_3SiO_{1/2}$ and SiO_2 units and having a $(CH_3)_3SiO_{1/2}/SiO_2$ ratio of 0.4/1 to 1.2/1; and
d) a condensate of said compound c) with said compound a) or b);

(3) 0.5 to 30 parts by weight of a finely divided filler for every 100 parts by weight of component (1);
(4) a catalytic amount of a compound for promoting the reaction of the other components.

5. A liquid laundry detergent containing surfactants, builders and at least one foam control agent, characterised in that the foam control agent, is a dispersible silicone antifoam composition according to any of claims 1 to 4.

6. A method of preparing a a non-aqueous emulsion of a silicone antifoam composition for providing controlled foaming aqueous medium formulations which comprises mixing together

(i) a primary antifoam agent being a reaction product of (a) a polyorganosiloxane fluid having at least one hydroxyl and hydrocarbonoxy group, (b) a resinous siloxane or a silicone resin-producing silicon compound, (c) a finely

divided filler material, and (d) a catalyst to promote the reaction of (a), (b) and (c),
(ii) a secondary antifoam agent being a polydimethysiloxane fluid,
(iii) at least one nonionic silicone surfactant,
(iv) a first organic surfactant dispersing agent and
(v) a second dispersing agent of a nonionic difunctional block copolymer terminating in primary hydroxyl groups.

7. A method of controlling the production of foam produced by a liquid laundry detergent in a wash liquor comprising adding to the detergent prior to the incorporation of the detergent into the wash liquor a dispersible silicone antifoam composition according to any of claims 1 to 4.

Patentansprüche

1. Eine dispergierbare, siliconhaltige Antischaumzusammensetzung, womit ein kontrolliertes Schäumen von Formulierungen in wäßrigem Medium erreicht wird, enthaltend eine Emulsion eines primären Antischaummittels, das ein Reaktionsprodukt (a) einer Polyorganosiloxanflüssigkeit mit wenigstens einer Hydroxyl- und Hydrocarbonoxygruppe, (b) eines harzartigen Siloxans oder einer Siliconharz erzeugenden Siliziumverbindung, (c) eines feinverteilten Füllstoffes und (d) eines Katalysators, um die Reaktion von (a), (b) und (c) zu fördern, ist,

   dadurch gekennzeichnet,
   daß die Zusammensetzung eine nichtwäßrige Emulsion ist und weiterhin ein sekundäres Antischaummittel, das eine Polydimethylsiloxanflüssigkeit ist, wenigstens ein nichtionisches, siliconhaltiges, oberflächenaktives Mittel, ein erstes organisches, oberflächenaktives, dispergierendes Mittel und ein zweites dispergierendes Mittel aus einem nichtionischen, difunktionellen Blockcopolymer mit endständigen primären Hydroxylgruppen enthält.

2. Eine dispergierbare, siliconhaltige Antischaumzusammensetzung nach Anspruch 1,

   dadurch gekennzeichnet,
   daß das primäre Antischaummittel zusätzlich eine Polyorganosiloxanflüssigkeit enthält, die frei von reaktiven Gruppen ist.

3. Eine dispergierbare, siliconhaltige Antischaumzusammensetzung nach Anspruch 1,

   dadurch gekennzeichnet,
   daß das primäre Antischaummittel gebildet wird durch Reaktion bei einer Temperatur von 50°C bis 300°C von
   (1) 1 bis 100 Gewichtsteilen eines Polyorganosiloxans mit einer Viskosität von $2x10^{-6}$ bis $1x10^{-1}$ m^2/s (20 bis 100.000 cs) bei 25°C und das durch die allgemeine Formel $R^1_aSiO_{(4-a)/2}$ wiedergegeben ist, in der R^1 eine monovalente Kohlenwasserstoff- oder halogenierte Kohlenwasserstoffgruppe mit 1 bis 10 Kohlenstoffatomen ist und a einen mittleren Wert von 1,9 bis 2,2 aufweist,
   (2) weniger als 5 Gewichtsteilen eines Polyorganosiloxans mit einer Viskosität von $2x10^{-4}$ bis mehreren m^2/s (200 bis mehreren Millionen cs) bei 25°C, wiedergegeben durch die allgemeine Formel $R^2_b(R^3O)_cSiO_{(4-b-c)/2}$, in der R^2 eine monovalente Kohlenwasserstoff- oder halogenierte Kohlenwasserstoffgruppe mit 1 bis 10 Kohlenstoffatomen ist, R^3 Wasserstoff oder eine monovalente Kohlenwasserstoffgruppe mit 1 bis 10 Kohlenstoffatomen ist, b einen mittleren Wert von 1,9 bis 2,2 aufweist und c einen ausreichend großen Wert aufweist, um mindestens eine $-OR^3$- Gruppe in jedem Molekül zu ergeben, wobei diese $-OR^3$-Gruppen wenigstens am Ende der molekularen Kette vorhanden sind, wobei die Gesamtheit der Komponenten (1) und (2) 100 Gewichtsteile ausmachen,
   (3) 0,5 bis 20 Gewichtsteilen pro 100 Gewichtsteile der Komponenten (1) und (2) einer oder mehrerer Verbindungen, die ausgewählt sind aus den folgenden a) bis d):

      a) einer Organosiliziumverbindung der allgemeinen Formel $R^4_dSiX_{4-d}$, in der R^4 eine monovalente Kohlenwasserstoffgruppe mit 1 bis 5 Kohlenstoffatomen ist, X eine hydrolysierbare Gruppe ist und d einen mittleren Wert von eins oder weniger aufweist,
      b) einem partiell hydrolysierten Kondensat dieser Verbindung a),
      c) einem Siloxanharz, im wesentlichen bestehend aus $(CH_3)_3SiO_{1/2}$ und SiO_2-Einheiten mit einem $(CH_3)_3SiO_{1/2}$/-SiO_2-Verhältnis von 0,4/1 bis 1,2/1, und
      d) einem Kondensat dieser Verbindung c) mit einer der Verbindungen a) oder b),

   (4) 0,5 bis 30 Gewichtsteilen eines feinverteilten Füllstoffs pro 100 Gewichtsteile dieser Komponenten (1) und (2),
   (5) einer katalytischen Menge einer Verbindung zur Förderung der Reaktion der anderen Komponenten und
   (6) 1 bis 20 Gewichtsteilen pro 100 Gewichtsteile dieser Komponenten (1) und (2) eines Polyorganosiloxans mit einer Viskosität von $50x10^{-6}$ bis $2x10^{-4}$ m^2/s (5 bis 200 cs) bei 25°C,

das durch die allgemeine Formel $R^8_e(R^9O)_fSiO_{(4-e-f)/2}$ wiedergegeben ist, bei der R^8 eine monovalente Kohlenwasserstoff- oder halogenierte Kohlenwasserstoffgruppe mit 1 bis 10 Kohlenstoffatomen ist, R^9 Wasserstoff oder eine monovalente Kohlenwasserstoffgruppe mit 1 bis 10 Kohlenstoffatomen ist, e im Mittel von 1,9 bis 2,2 beträgt und f einen ausreichend großen Wert hat, um wenigstens zwei $-OR^9$-Gruppen in jedem Molekül am Ende der molekularen Kette zu ergeben.

4. Eine dispergierbare, siliconhaltige Antischaumzusammensetzung nach Anspruch 1,

dadurch gekennzeichnet,
daß das primäre Antischaummittel gebildet wird durch Reaktion bei einer Temperatur von 50°C bis 300°C von
(1) weniger als 5 Gewichtsteilen eines Polyorganosiloxans mit einer Viskosität von $2x10^{-4}$ bis mehreren m^2/s (200 bis mehreren Millionen cs) bei 25°C, wiedergegeben durch die allgemeine Formel $R^2_b(R^3O)\ SiO_{(4-b-c)/2}$, in der R^2 eine monovalente Kohlenwasserstoff- oder halogenierte Kohlenwasserstoffgruppe mit 1 bis 10 Kohlenstoffatomen ist, R^3 Wasserstoff oder eine monovalente Kohlenwasserstoffgruppe mit 1 bis 10 Kohlenstoffatomen ist, b einen mittleren Wert von 1,9 bis 2,2 aufweist und c einen ausreichend hohen Wert hat, um wenigstens eine $-OR^3$- Gruppe in jedem Molekül zu ergeben, wobei diese $-OR^3$- Gruppe wenigstens am Ende der Molekularkette vorhanden ist,
(2) 0.5 bis 20 Gewichtsteilen pro 100 Gewichtsteile der Komponente (1) einer oder mehrerer Verbindungen, die ausgewählt sind aus den folgenden a) bis d):

a) einer Organosiliziumverbindung der allgemeinen Formel $R^4_dSiX_{4-d}$, in der R^4 eine monovalente Kohlenwasserstoffgruppe mit 1 bis 5 Kohlenstoffatomen ist, X eine hydrolysierbare Gruppe ist und d einen mittleren Wert von eins oder weniger aufweist,
b) einem partiell hydrolysierten Kondensat dieser Verbindung a),
c) einem Siloxanharz, im wesentlichen bestehend aus $(CH_3)_3SiO_{1/2}$ und SiO_2-Einheiten mit einem $(CH_3)_3SiO_{1/2}/SiO_2$-Verhältnis von 0,4/1 bis 1,2/1, und
d) einem Kondensat dieser Verbindung c) mit einer der Verbindungen a) oder b),

(3) 0,5 bis 30 Gewichtsteilen eines feinverteilten Füllstoffs pro 100 Gewichtsteile der Komponente (1),
(4) einer katalytischen Menge einer Verbindung zur Förderung der Reaktion der anderen Komponenten.

5. Ein flüssiges Waschmittel, das oberflächenaktive Mittel, Builder und wenigstens ein Schaumregulierungsmittel enthält,

dadurch gekennzeichnet,
daß das Schaumregulierungsmittel eine dispergierbare, siliconhaltige Antischaumzusammensetzung entsprechend einem der Ansprüche 1 bis 4 ist.

6. Ein Verfahren zur Herstellung einer nichtwäßrigen Emulsion einer siliconhaltigen Antischaumzusammensetzung, wodurch ein kontrolliertes Schäumen von Formulierungen in wäßrigem Medium ermöglicht wird, durch Zusammenmischen von

(i) einem primären Antischaummittel, das ein Reaktionsprodukt von (a) einer Polyorganosiloxanflüssigkeit mit wenigstens einer Hydroxyl- und Hydrocarbonoxygruppe, (b) einem harzartigen Siloxan oder einer Siliconharz ergebenden Siliziumverbindung, (c) einem feinverteilten Füllstoff und (d) einem Katalysator, der die Reaktion von (a), (b) und (c) fördert, ist
(ii) einem sekundären Antischaummittel, das eine Polydimethylsiloxanflüssigkeit ist,
(iii) wenigstens einem nichtionischen, siliconhaltigen, oberflächenaktiven Mittel,
(iv) einem ersten organischen, oberflächenaktiven, dispergierenden Mittel und
(v) einem zweiten dispergierenden Mittel aus einem nichtionischen difunktionellen Blockcopolymer mit endständigen primären Hydroxylgruppen.

7. Ein Verfahren zur Regulierung der Schaumbildung, die durch ein flüssiges Waschmittel in einer Waschlauge erzeugt wird, durch Zugeben zu dem Waschmittel vor dem Einbringen des Waschmittels in die Waschlauge einer dispergierbaren, siliconhaltigen Antischaumzusammensetzung nach einem der Ansprüche 1 bis 4.

Revendications

1. Une composition antimousse dispersable aux silicones pour produire des formulations à moussage réglé en milieu aqueux, comprenant une émulsion d'un agent antimousse primaire qui est un produit réactionnel de (a) un fluide de polyorganosiloxane ayant au moins un groupe hydroxyle et un groupe hydrocarbonoxy, (b) un siloxane résineux ou un composé silicié produisant une résine de silicone, (c) une matière de charge finement divisée et (d) un

catalyseur pour activer la réaction de (a), (b) et (c), caractérisée en ce que la composition est une émulsion non aqueuse et contient de plus un agent antimousse secondaire qui est un fluide de polydiméthylsiloxane, au moins un agent tensio-actif non ionique du type silicone, un premier agent dispersant tensio-actif organique et un second agent dispersant qui est un copolymère séquencé difonctionnel non ionique terminé par des groupes hydroxyle primaires.

2. Une composition antimousse dispersable aux silicones selon la revendication 1, dans laquelle l'agent antimousse primaire comprend de plus un fluide de polyorganosiloxane qui est exempt de groupes réactifs.

3. Une composition antimousse dispersable aux silicones selon la revendication 1, dans laquelle l'agent antimousse primaire est formé en faisant réagir à une température de 50°C à 300°C .

(1) 1 à 100 parties en poids d'un polyorganosiloxane ayant une viscosité de 2×10^{-5} à 1×10^{-1} m^2/s à 25°C et représenté par la formule générale $R^1{}_aSiO_{(4-a)/2}$ où R^1 est un groupe hydrocarboné ou hydrocarboné halogéné monovalent ayant 1 à 10 atomes de carbone et la valeur moyenne de a est de 1,9 à 2,2 ;
(2) moins de 5 parties en poids d'un polyorganosiloxane ayant une viscosité de 2×10^{-4} à plusieurs m^2/s à 25°C, représenté par la formule générale $R^2{}_b(R^3O)_cSiO_{(4-b-c)/2}$ où R^2 est un groupe hydrocarboné ou hydrocarboné halogéné monovalent ayant 1 à 10 atomes de carbone, R^3 est l'hydrogène ou un groupe hydrocarboné monovalent ayant 1 à 10 atomes de carbone, la valeur moyenne de b est de 1,9 à 2,2 et la valeur de c est suffisamment grande pour qu'il y ait au moins un groupe $-OR^3$ dans chaque molécule, ledit groupe $-OR^3$ étant présent au moins à l'extrémité d'une chaîne moléculaire ; le total des constituants (1) et (2) étant de 100 parties en poids ;
(3) 0,5 à 20 parties en poids, pour 100 parties en poids desdits constituants (1) et (2), d'un ou plusieurs composés choisis parmi a) à d) ci-dessous :

a) un composé organosilicié de la formule générale $R^4{}_dSiX_{4-d}$ où R^4 est un groupe hydrocarboné monovalent ayant 1 à 5 atomes de carbone, X est un groupe hydrolysable et la valeur moyenne de d est égale ou inférieure à 1 .
b) un produit d'hydrolyse et condensation partielles dudit composé a) ;
c) une résine de siloxane constituée essentiellement de motifs $(CH_3)_3SiO_{1/2}$ et SiO_2 et ayant un rapport $(CH_3)_3SiO_{1/2}/SiO_2$ de 0,4/1 à 1,2/1 ; et
d) un produit de condensation dudit composé c) avec ledit composé a) ou b) ;

(4) 0,5 à 30 parties en poids d'une charge finement divisée pour 100 parties en poids desdits constituants (1) et (2) ;
(5) une quantité catalytique d'un composé servant à activer la réaction des autres constituants ; et
(6) 1 à 20 parties en poids, pour 100 parties en poids desdits constituants (1) et (2), d'un polyorganosiloxane ayant une viscosité de 5×10^{-6} à 2×10^{-4} m^2/s à 25°C et représenté par la formule générale $R^8{}_e(R^9O)_fSiO_{(4-e-f)/2}$ où R^8 est un groupe hydrocarboné ou hydrocarboné halogéné monovalent ayant 1 à 10 atomes de carbone, R^9 est l'hydrogène ou un groupe hydrocarboné monovalent ayant 1 à 10 atomes de carbone, e est de 1,9 à 2,2 en moyenne et la valeur de f est suffisamment grande pour qu'il y ait au moins deux groupes $-OR^9$ dans chaque molécule à l'extrémité d'une chaîne moléculaire.

4. Une composition antimousse dispersable aux silicones selon la revendication 1, dans laquelle l'agent antimousse primaire est formé en faisant réagir à une température de 50°C à 300°C :

(1) moins de 5 parties en poids d'un polyorganosiloxane ayant une viscosité de 2×10^{-4} à plusieurs millions de m^2/s à 25°C, représenté par la formule générale $R^2{}_b(R^3O)_cSiO_{(4-b-c)/2}$ où R^2 est un groupe hydrocarboné ou hydrocarboné halogéné monovalent ayant 1 à 10 atomes de carbone, R^3 est l'hydrogène ou un groupe hydrocarboné monovalent ayant 1 à 10 atomes de carbone, la valeur moyenne de b est de 1,9 à 2,2 et la valeur de c est suffisamment grande pour qu'il y ait au moins un groupe $-OR^3$ dans chaque molécule, ledit groupe $-OR^3$ étant présent au moins à l'extrémité d'une chaîne moléculaire ;
(2) 0,5 à 20 parties en poids, pour 100 parties en poids du constituant (1), d'un ou plusieurs composés choisis parmi a) à d) ci-dessous :

a) un composé organosilicié de la formule générale $R^4{}_dSiX_{4-d}$ où R^4 est un groupe hydrocarboné monovalent ayant 1 à 5 atomes de carbone, X est un groupe hydrolysable et la valeur moyenne de d est égale ou inférieure à 1 ;
b) un produit d'hydrolyse et condensation partielles dudit composé a) ;

c) une résine de siloxane constituée essentiellement de motifs $(CH_3)_3SiO_{1/2}$ et SiO_2 et ayant un rapport $(CH_3)_3SiO_{1/2}/SiO_2$ de 0,4/1 à 1,2/1 ; et
d) un produit de condensation dudit composé c) avec ledit composé a) ou b) ;

(3) 0,5 à 30 parties en poids d'une charge finement divisée, pour 100 parties en poids dudit constituant (1) ;
(4) une quantité catalytique d'un composé servant à activer la réaction des autres constituants.

5. Un détergent liquide de blanchissage contenant des agents tensio-actifs, des adjuvants de détergence et au moins un agent régulateur de mousse, caractérisé en ce que l'agent régulateur de mousse est une composition antimousse dispersable aux silicones selon l'une quelconque des revendications 1 à 4.

6. Un procédé de préparation d'une émulsion non aqueuse d'une composition antimousse aux silicones pour produire des formulations à moussage réglé en milieu aqueux, qui consiste à mélanger ensemble

(i) un agent antimousse primaire qui est un produit réactionnel de (a) un fluide de polyorganosiloxane ayant au moins un groupe hydroxyle et un groupe hydrocarbonoxy, (b) un siloxane résineux ou un composé silicié produisant une résine de silicone, (c) une matière de charge finement divisée et (d) un catalyseur pour activer la réaction de (a), (b) et (C),
(ii) un agent antimousse secondaire qui est un fluide de polydiméthylsiloxane,
(iii) au moins un agent tensio-actif non ionique du type silicone,
(iv) un premier agent dispersant tensio-actif organique, et
(v) un second agent dispersant qui est un copolymère séquencé difonctionnel non ionique terminé par des groupes hydroxyle primaires.

7. Un procédé pour régler la production de mousse produite par un détergent liquide de blanchissage dans une liqueur de lavage, consistant à ajouter au détergent, avant l'introduction du détergent dans la liqueur de lavage, une composition antimousse dispersable aux silicones selon l'une quelconque des revendications 1 à 4.